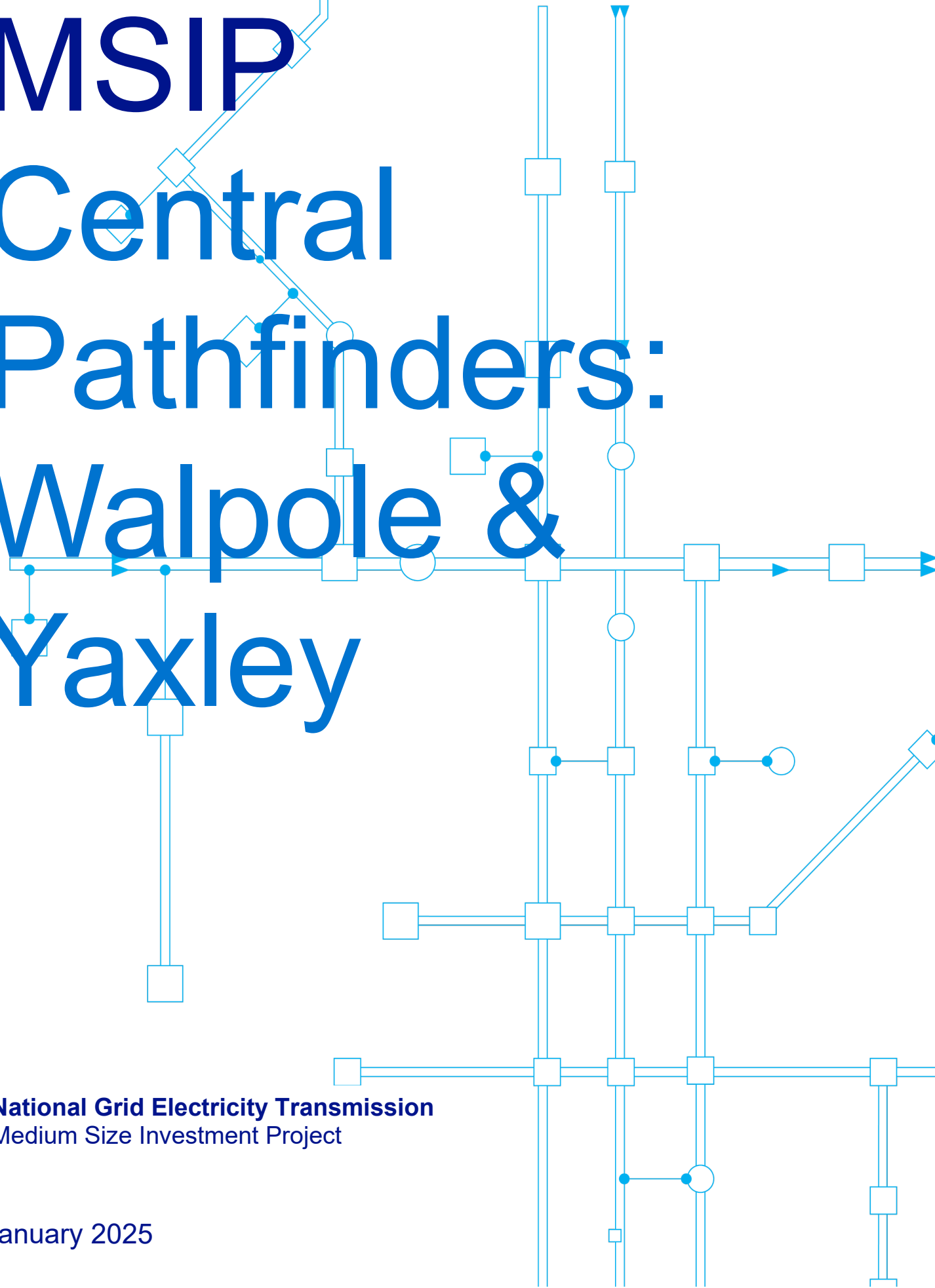
MSIP Central Pathfinders: Walpole & Yaxley



National Grid Electricity Transmission
Medium Size Investment Project

January 2025

Contents

Investment Summary

Project Name	Walpole & Yaxley Grid Stability Pathfinders	**Delivery year**	[redacted]
Drivers for the Investment	**NESO Driven Pathfinder – to ensure grid stability in the East of England region in response to the increasing integration of renewable energy sources and the phasing out of traditional power generation.** Conrad Energy (customer) were awarded contracts by NESO in 2022, through the Stability Pathfinder Phase 3 tender process, to provide grid stability services in the East of England. The contracts require the development and installation of a combined 3 Synchronous Condensers across Walpole (2) and Yaxley (1) 400kV substations in the East of England. Conrad Energy require a connection of the units to the transmission System via the substations. Infrastructure works are required to provide a customer connection to Conrad Energy under these contractual obligations. These works form the subject of this submission.		
Key considerations & challenges	• **Timings:** The short timeframe between the signing of connection agreements at both substations and NESO's anticipation of connections for the Pathfinder programme, combined with supply chain constraints, presents significant challenges. These are being actively addressed in collaboration with Conrad Energy and relevant stakeholders to ensure timely delivery, meeting NESO obligations, and realising the benefits of reduced constraint costs. • **Land:** the proximity of Synchronous Condensers to the substations has implications on their performance. Additionally, space constraints at Walpole meant alternative arrangements were made to the initially reserved space for connecting the Condensers. • **Outages:** coordination of planned outages is essential, as delays or overruns in outages for related works could impact the overall delivery of the projects.		
Optioneering	As part of our standard process, we assessed three options for connecting Conrad Energy's Synchronous Condensers at Walpole and Yaxley substations: "do nothing," using existing substations, using alternative sites or building new assets: • We considered that the option to do nothing would not address the grid stability requirements identified by NESO and this option was discounted. • Due to prior NESO and NGET feasibility assessments, the existing Walpole substation and developing Yaxley site were identified and pre-selected as suitable to accommodate Pathfinder solutions, confirming that it was unnecessary to build new substations. This enabled us to focus our optioneering process on the configuration of the sites with infrastructure modifications to accommodate the connections for the Condensers.		
Proposed Solution	<u>Walpole</u> NGET will extend the eastern end of the Walpole substation to accommodate one new connection bay for two Synchronous Condensers. The scope of work includes extending the substation platform, ISS fence, drainage system, as well as extending the main and reserve busbars, the substation control system (SCS) extension and the busbar protection. <u>Yaxley</u> NGET will install a GIS connection bay and associated 400kV Gas Insulated Busbar (GIB), with G3 technology, to allow interface between Yaxley substation and the customer's Condenser connection cable, supported by associated civil and electrical works. These solutions ensure the necessary infrastructure is in place to connect Conrad Energy's Synchronous Condensers at both substations.		
Outputs of the Investment	Delivering the infrastructure for the deployment of the Synchronous Condensers in the East of England enhances grid stability in the region by providing inertia and short circuit levels traditionally supplied by coal and gas generation. Without the collective Pathfinders across all regions, NESO		

[1] [redacted]

	estimate that managing stability in England and Wales would cost consumers an additional £14.9bn in constraint action between 2025 and 2035. The Condensers also enable greater integration of renewables, supporting the UK's Net Zero targets for a cost-effective energy transition.		
PCD Primary Output	• Extension of the substation and associated works at Walpole to connect Conrad Energy's NESO Pathfinder solutions by [redacted] • Installation of a substation bay and associated works at Yaxley to connect Conrad Energy's NESO Pathfinder solutions by [redacted]		
Estimated Cost (price base 2018/19)	Our total cost for the investment and funding allowance being sought for Walpole and Yaxley respectively is: • The current total cost of the projects is [redacted] and [redacted] respectively. • The total direct cost of the projects – the funding this MSIP seeks – is [redacted] and [redacted] respectively.		
Spend profile	**T2 (FY2022 – FY2026):** Walpole: [redacted] Yaxley: [redacted]	**T3 (FY 2027 – FY2031):** Walpole: [redacted]	**T4+ (FY 2032+):**
Reporting table	Annual RRP – PCD Table RIIO-T3 Pipeline Log – 10.5	**PCD Modification Process**	Special Condition 3.14, Appendix 1
Historic funding interactions	No existing funding in RIIO-T1 or RIIO-T2.		

1. Executive summary

1.1 Context

This paper presents NGET's proposed investments in the required scope of works at Walpole and Yaxley 400kV substations to enable the connection of Synchronous Condensers to the transmission network, and seeks to demonstrate the consumer interest in the associated investment.

These Condensers, which are outcomes of the NESO Pathfinder scheme, are critical components for maintaining grid stability in the East of England region in response to the increasing integration of renewable energy sources and the decommissioning of traditional power stations, which previously provided this stability.

This Medium Sized Investment Project (MSIP) paper seeks approval of the need for the investment, as well as approval of the proposed solution. A full funding allowance request has been provided alongside this paper for the Yaxley investment. However, an indicative funding allowance request has been provided alongside this MSIP for the Walpole Investment. As agreed with Ofgem, requested funding allowances for efficient spend on the Walpole project will be sought via an updated submission in Q1 2025 as agreed with Ofgem.

1.2 What is the background to this Investment?

As part of their function, NESO has a responsibility to prepare the grid network for the transition to renewable energy. Recent changes in decarbonisation, decentralisation and digitalisation are driving significant change across the electricity network, impacting how the transmission system needs to be operated. By 2030 it is expected there will be significant offshore wind generation and interconnection, both of which will present operability challenges.

Grid stability, which has traditionally been supplied as an inherent by-product of traditional generation (coal and gas plants), represents one of those challenges. As traditional generation is phased out, there is a decline in the inherent stability of the system with inertia and short circuit levels falling. A power network operating without required levels of mechanical inertia is unstable, suffers from issues of power quality and is susceptible to blackouts.

In 2021, NESO identified five 'regions of need', for which stability solutions were required on the transmission system, and issued a tender to procure services and proposals to deliver sustainable solutions at low cost. This process is known as the NOA Stabiilty Pathfinder Phase 3. Conrad Energy were awarded contracts from the tendering process in Q4 2022 to deliver stability solutions for the East of England region. To deliver on their contracts with NESO, Conrad Energy will connect Synchronous Condensers (sometimes called a synchronous compensator) , a specialised piece of equipment that does not generate power but provides stability and voltage support, to the transmission system. Two of these Condensers are to be connected at Walpole substation, and one is to be connected at Yaxley substation. The contractual connections agreement between NESO and NGET for the connection of Conrad Energy's Pathfinder Condensers were signed in May 2023 for both Walpole and Yaxley, which led very tight timescales for optioneering and delivery of stability solutions.

Prior to publishing the pre-tender consultation for the Pathfinders, NESO requested NGET to complete a high-level analysis to confirm which substations within each region of need could accommodate a new connection for stability solutions. Walpole and Yaxley substations were identified by NESO as suitable Grid Supply Points (GSPs) in which there was capacity and sufficient technical effectivenss to support the grid stability Pathfinder scheme in the East of England region, and capacity was therefore reserved at both substations.

As the operator of the transmission system, and to ensure compliance with Security and Quality of Supply Standard (SQSS), NGET is responsible for ensuring that the stability solutions integrate safely and effectively within the network. While Conrad Energy was awarded the contract to deliver the stability scheme through NESO's tender, the actual connection of the Synchronous Condenser solutions to the transmission system requires infrastructure modifications at the respective substations, which falls under NGET's remit.

1.3 What have we considered in developing options for this investment?

NGET assessed solutions to meet the investment driver in a way that best serves the interests of consumers. We evaluated several possible options to identify the best solution for consumers, including "do nothing," using existing substations, using alternative substations or building a new substation.

In collaboration with NESO, we had conducted a feasibility study ahead of the NESO Pathfinder tendering process, in which we concluded that the existing Walpole substation and the developing Yaxley site possessed sufficient capacity to accommodate Pathfinder solutions. On this basis, NESO had therefore reserved capacity for successful Pathfinder participants at both sites ahead of completing their tender process. Our optioneering process was therefore focussed on confirming the NESO reservations were still feasible, configuring the sites with infrastructure modifications necessary to accommodate connections for the Condensers.

A “do nothing” approach was deemed unacceptable as it could lead to operational risks on the transmission system which would require balancing actions at a cost to consumers. Additionally, this option would compromise the broader decarbonisation agenda.

The existing infrastructure at Walpole and Yaxley met both the capacity and technical requirements for the delivery of solutions to connect the Condensers to the transmission system, and hence the NESO-driven Pathfinders did not necessitate the construction of a new substation or alternative site.

The connection of the Condensers at Walpole could be made effectively through the use of existing infrastructure, albeit with adjustments and expansions amidst the spatial constraints. At Yaxley, a new substation under development, the connection bays for the Condensers could be efficiently integrated to its design through the addition of new bays. This would necessitate a change in scope during the delivery of the project.

We therefore considered how to efficiently to configure the spatial arrangements, and infrastructure works to accommodate the capacities that had already been reserved by NESO:

- At Walpole, this involved addressing site congestion through adjustments to determine an optimal location for connections within the substation due to constraints, amidst other infrastructure developments at the substations.
- At Yaxley, the new GIS substation, considerations focused on saving consumer costs and time by integrating the Pathfinder scope into the developing substation construction for the connection of Progress Power OCGT power station - which did not initially include connection bays for the Condensers.

1.4 What is the preferred option and what outputs does it deliver?

Walpole: extension at the far eastern section of the substation which makes provision for a single bay to connect Conrad Energy's two Synchronous Condensers to the transmission system. This includes the extension of the substation platform and ISS fence-line, main and reserve busbars, busbar protection, and SCS extension.

Yaxley: the inclusion of an additional bay to the initial design and scope of works for the developing substation to accommodate the connection of a single Synchronous Condenser. The scope of works includes installation and commissioning of a 400kV GIS Bay, the Gas Insulating Busbar (GIB) and associated electrical and mechanical work which will serve as the interface between the GIS substation and the connecting cable to a single Synchronous Condenser.

By facilitating the connection of Synchronous Condensers at these sites, these projects address the challenges of maintaining grid stability amidst the growing integration of renewable energy in the East of England region and the retirement of traditional power stations. NESO projects that the collective contracts awarded through Pathfinder Phase 3 for projects across all regions will deliver an estimated **£14.9 billion in consumer savings between 2025 and 2035**.

Funding allowances are sought as part of this MSIP submission. The total and direct costs for both investments are [redacted] and [redacted] (18/19 prices). Further details related to the makeup of these requested allowances are detailed within the cost models available alongside this submission.

1.5 How has future proofing been considered in the proposed investment?

At Yaxley, two connection bays were initially planned to enable the connection of two Synchronous Condensers as part of the substation construction. However, following updated instructions from NESO, only one Condenser was required and therefore only one bay was needed to accommodate a single Condenser. Despite this, the decision was made to proceed with constructing the additional bay to futureproof the substation for expected future connections. Our assessment was that this approach would be in the interest of future consumers, as building the bay during the initial construction avoided the higher costs and disruptions of adding it later. It is important to note that this additional bay therefore does not form part of the scope of this MSIP funding request but was included in the substation construction for operational and cost efficiencies.

Within Walpole, NGET are developing a site strategy to accommodate the multiple customers that are expected to the site. This will include a new section to the 400kV substation to allow for additional generation and power flow. Full consideration of the site architecture was required to ensure that the proposed site could be maximised not only for Conrad energy, but also for other customers and ensuring consumer value.

1.6 What are the uncertainties and how have they been accounted for?

A key consideration for both projects is the condensed period between the NGET-NESO connection agreement (May 2023) and the Pathfinder programme delivery timescales required (late [redacted], albeit with communicated estimated delivery times of [redacted]). This manifested into several risks and uncertainties noted below, which are specific to each project.

Walpole

- Contractor Delivery: Given prevailing supply chain constraints and conditions, there is an ongoing risk that the contractors may not deliver in a timely manner, which could lead to delays. There is ongoing dialogue with contractors to incentivise earlier delivery of relevant works.
- Cost Escalation: The tight supply chain market and the urgency to meet the revised ACL date necessitated the adoption of an Option E contract, which carries inherent risks of cost escalation. To address these risks, the contractor will have an onsite Quantity Surveyor (QS) to monitor costs in real-time, and NGET will increase its own onsite QS presence to provide enhanced oversight and tighter cost control.

Yaxley

- Supplier Design: The GIB manufacturer has previously made changes to the design specification of GIB's they produced which has resulted in a long procurement lead time. This has been a primary source of delay to project programme. Further manufacturer programme issues could result in further delays. We have introduced additional project management support to monitor the contractor to anticipate risks and plan accordingly.
- [redacted]

Following a NESO-driven investment driver to enhance grid stability in the East of England, NGET will implement infrastructure works to connect Synchronous Condensers at both Walpole and Yaxley substations as grid stability solutions.

At Walpole, the solution is to extend the 400kV substation to accommodate a user bay to host the connection of the Synchronous Condensers. At Yaxley, the solution is to integrate an additional bay into the design and construction of the developing substation to accommodate the connection of the Condensers. Another bay which was also constructed for a Condenser, but no longer required, will be used to facilitate future customers.

The investment in infrastructure works to facilitate the projects enable the delivery of essential grid stability services and support the long-term energy transition, protecting the interests of both current and future consumers.

2. Introduction

2.1 Project background

This paper presents the investment case and associated efficient/indicative[2] efficient costs for the grid stability projects at Walpole and Yaxley substations which support the UK's decarbonisation goals and achieving a net-zero economy by 2050. To realise these targets, the UK would need to quadruple solar and wind electricity generation[3]. As the transition to renewable energy accelerates, it has created a need for innovative stability solutions to maintain grid reliability as the stabilising properties traditionally provided by coal and gas-fired power stations are phased out.

Grid stability refers to the ability to quickly return to acceptable operation following a disturbance. The decline of synchronous traditional power sources has reduced system inertia and short circuit level (SCL), which are two critical components of grid stability. With the decline of these stabilising factors, the inherent resilience of the electricity system is compromised, making it imperative to adopt new technologies to support the grid as it integrates more non-synchronous renewable energy sources like wind and solar.

2.1.1 MSIP Eligibility

The Walpole and Yaxley Pathfinder connection projects meet the MSIP criteria under SpC 3.14.6 (f) as NESO-driven system operability projects. The associated infrastructure works are essential to deliver grid stability services in the East of England, supporting the connection of Synchronous Condenser solutions under NESO's Stability Pathfinder Phase 3.

Whilst we are submitting this MSIP submission in the January 2025 MSIP reopener window to evidence and seek approval of the investment needs case for the project, we are not seeking funding allowances for full efficient costs for Walpole as part of this submission.

As agreed with Ofgem in January 2025, NGET will not obtain full cost clarity for the Walpole investment until [redacted], due to contracting arrangements necessitating the use of an Option E contract. As such, the cost model provided alongside this submissions for Walpole is an indicative summary of efficient costs only. We will follow up with an updated funding request to this submission subsequently.

[2] Full efficient costs for Walpole will be presented in a resubmission later in 2025 as agreed with Ofgem.
[3] Net Zero Strategy: Build Back Greener - GOV.UK

2.1.2 Chronology to the request

NESO Identification of GB Stability Needs (January 2021 – September 2021)	• NESO's System Operability Framework highlighted the operability risks associated with declining traditional generation, driving the need for stability solutions. • NESO requested NGET to complete an initial analysis to confirm which substations within each region of need could accommodate a new connection for stability solutions.
Pre-Tender Consultation and Expression of Interest (EOI) (September 2021 – November 2021)	• NESO published draft tender documents, including technical specifications. Market participants were invited to express their interest in the tender. • NESO reserved a number of connection points (bays) on the network, based on technical effectiveness and connection opportunities, for tender participants to implement solutions - including at Walpole & Yaxley.
Tender Launch (December 2021 – June 2022)	• Registered participants submitted technical and commercial proposals. • NGET feasilibily study report was produced for the reserved connection points at the substations to inform tender submissions. • The tender submission deadline was 6 June 2022.
Pathfinder Contract Awards (November 2022)	• NESO awarded contracts worth £1.3 billion to six companies for solutions providing 17MW.s of inertia and 8.7 MVA of short circuit level across England and Wales.
NGET-NESO Connection Contracts Signed (May 2023)	• Walpole: NGET Connection Offer signed on 31/05/2023. • Yaxley: Orginal NGET Connection Offer signed on 25/05/2023.

NESO Stability Pathfinder Phase 3 programme

The National Electricity System Operator (NESO) is responsible for ensuring the security, operability, and reliability of the electricity system. As part of this mandate, NESO must procure or fund solutions where necessary to address system stability challenges resulting from the rapid integration of renewable energy sources.

NESO's Stability Pathfinder Phase 3 programme sought to address grid stability challenges via a competitive tender process for the procurement of inertia and SCL across five identified "regions of need" in England and Wales, including the East of England where Walpole and Yaxley 400kV substations are located. For the East of England, 2000 MVA of SCL was determined to be required to support grid stability and meet future demands. Table 4 in section 3.2 presents the stability requirements determined by NESO for each region of need.

Outcome of the NESO Grid Stability Pathfinder Phase 3 Procurement

The outcome of NESO's Stability Phase 3 tendering process for procuring grid stability solutions in the East of England region is summarised in the Table 1 below. The process focused on providing Short Circuit Level (SCL) and associated inertia to meet locational grid stability needs. For each region, a reference site was chosen, and the SCL effectiveness of nearby substations were evaluated relative to this site. In the East of England, Norwich Main and Bicker Fen served as the reference sites. The selection of Walpole and Yaxley as suitable grid entry points reflected the importance of proximity to the reference sites for sufficient SCL effectiveness within each region.

Assessment of the N-1 condition was included in the Pathfinder tender as a standard reliability measure in electricity networks. This accounts for the largest single contingency, such as the failure of a significant grid asset. In the tendering process, N-1 represents the remaining SCL after accounting for the loss of the largest contributing grid asset.

Awarding of Contracts

Conrad Energy were awarded contracts in November 2022 to provide 1225 MW.s of inertia at Walpole and 617 MW.s of inertia at Yaxley, leveraging two and one synchronous condensers, respectively. Following contract award, successful tender participants that planned to connect their solution(s) to the network via one of the NESO reserved connection points were then able to apply for their already reserved connection via the formal connection process. Conrad Energy received connection offers to connect at Walpole and Yaxley substations, with contracts signed in May 2023.

Planning Approval

In Q1 2023, Conrad Energy were granted planning approval to build a Synchronous Condenser on land adjacent to Yaxley substation. The project is located at The Leys and Ivy Farm, Mellis Road, Yaxley. A further application[4] to make a minor amendment to the layout and configuration of the development, known as a section 73 application under the Town and Country Planning Act, was granted approval in June 2023. Similarly, at Walpole planning approval was granted in Q1 2023 at land at Rose Hall Farm, Walpole Bank, for the construction of two Synchronous Condensers to connect to the substation. Following this, in December 2023, Conrad Energy was granted planning consent for the installation of their user bay at Walpole 400kV Substation.

NGET's role

As the transmission system owner, NGET is responsible for operating and maintaining the high-voltage electricity transmission network in England and Wales. We are therefore required to integrate and connect the Pathfinder grid stability solutions in line with the system stability needs identified by NESO. Additionally, NGET has a duty to connect entities to the transmission network upon request.

[4] Conrad Energy Planning Application =- Construction and operation of Synchronous Condensers with ancillary infrastructure, and associated works including access and landscaping. | Land At The Leys And Ivy Farm Mellis Road Yaxley

Table 1: SCL & Inertia procured by NESO following the Pathfinder tendering process

East of England					
Company Name	**Technology Type**	**Grid Entry Point**	**SCL(MVA) Effective at Norwich**	**SCL(MVA) Effective at Bicker Fen**	**Inertia (MW.s)**
Conrad Energy	2 SynComp	Walpole 400kV	589	1355	1225
Conrad Energy	1 SynComp	Yaxley 400kV	893	256	617
Statkraft UK	SynComp	Necton 400kV	855	461	4074
Statkraft UK	SynComp	Necton 400kV	135	71	69
		Total SCL (MVA)	**2472**	**2143**	**5985**
		Total SCL for N-1 (MVA)	1482	788	
		Requirement (MVA)	1500	500	
		Amount for N-1 not procured (MVA)	18		

N-1 Shortfall Relative to Norwich Main

NESO need to ensure that the SCL needs could be met in each region even when a solution becomes unavailable. Generally, this would mean that the unavailability of the largest provider in each region would need to be secured against (N-1).

If the largest contributor to Norwich Main's SCL becomes unavailable (Statkraft UK's primary solution at Necton 400kV, contributing 855 MVA), the remaining SCL is 1482 MVA. Given that there is an SCL requirement at Norwich Main of 1500MVA, the N-1 shortfall is 18MVA. This 18MVA shortfall means that, under the N-1 condition, Norwich Main does not meet the minimum required SCL for stability by a small margin. Addressing this shortfall would require additional stability solutions. However, NESO deemed this shortfall as uneconomic to resolve through the Pathfinder tendering process. Instead, it decided to manage this small gap via the Balancing Mechanism (BM), which can provide temporary adjustments to meet grid stability requirements.

2.2 Regional and strategic context

2.2.1 Overview of the substations

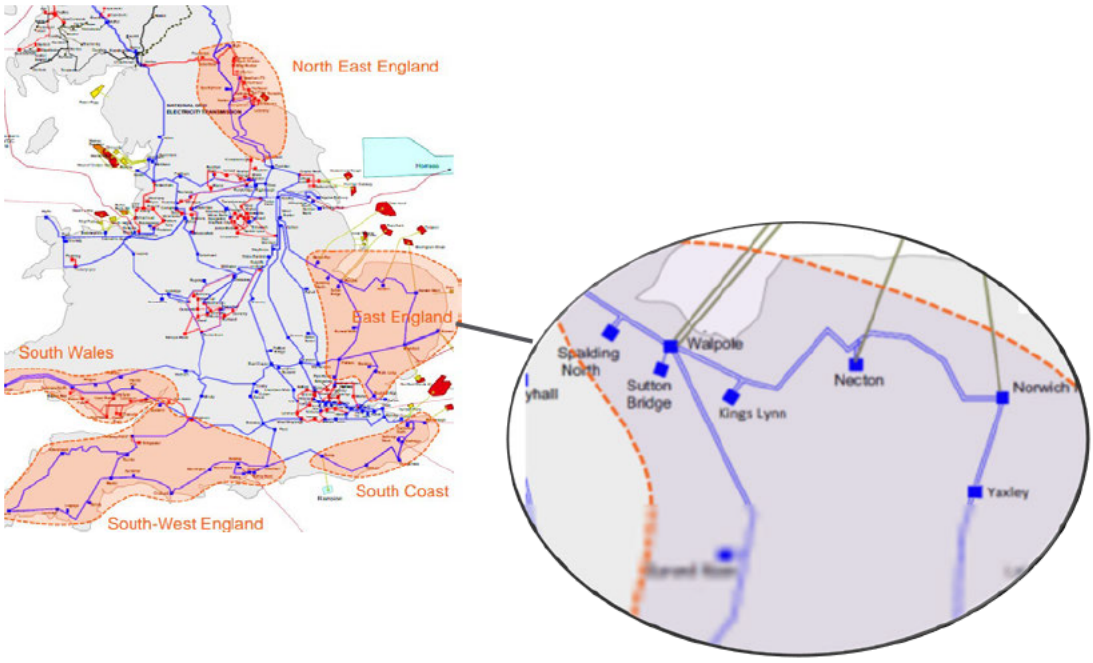


Figure 1: Location of Walpole and Yaxley substations in the East of England Region

The substations relevant to this MSIP submission are those in which stability solutions will be integrated and connected to meet NESO Pathfinder requirements, namely Walpole and Yaxley. This will be achieved in collaboration with the connection customer, Conrad Energy, who has been awarded contracts by NESO to deliver their stability Pathfinder projects. Below is an overview of the substations:

1. **Walpole 400kV Substation – East of England**

The Walpole 400kV substation, located near Wisbech in Norfolk, England, is a key asset within the National Grid's transmission network. Serving as an important connection point in the eastern part of the network, Walpole enables the distribution of high-voltage electricity across the region. Built in the 1960s and featuring Air Insulated Switchgear (AIS), the substation is undergoing significant upgrades to support renewable energy integration and meet future demand.

Current connections:

- Race Bank Offshore Wind Farm
- Lincs Onshore Wind Farm
- Sutton Bridge Power Station
- Sutton Bridge Solar Farm
- Multiple 400kV double circuit overhead lines connecting:
  - Norwich Main 1 & 2
  - Burwell 1 & 2
  - Spalding North & Bicker Fen
- Connection to 132kV substation serving two Distribution Network Operators (DNOs).

Planned connections and expansions:

- Installation of a 60MVA tertiary transformer to connect a Solar Farm and Battery Energy Storage System (BESS) by 2025.
- 132kV ENSO 2 connection
- WALP1-249MW Conn for Eclipse IDNO Ltd
- WALP4: CB Replacement
- WALP4: Evolution Power
- WALP4 diversion of NORW cct1 – KLYNNB

2. Yaxley 400kV Substation – East of England

The Yaxley 400kV substation, located in Suffolk, East of England, is a Gas-Insulated Substation (GIS) being developed to connect new power generation and enhance the capacity of the national grid in the region. The substation is under construction and expected to go live by early [redacted].

Current Connection:

- Progress Power Gas-Fired Generating Plant: A Drax Group development designed to operate as a peak power plant, enhancing the region's energy security.

Potential future connections:

- The substation is designed with an additional bay to accommodate future customers, with some connections potentially materialising in the 2030s.

2.2.2 Growth of renewable generation

The Future Energy Scenarios highlight that growth in low-carbon and renewable generation over the next decade will primarily drive the system needs in the East of England region[5]. About a third of today's UK energy demand could be met by the energy that will be coming into East Anglia by the end of the decade. Additionally, the existing network will also be strongly influenced by future development outside of the region such as wind generation in the North and interconnector behaviour in the South Coast.

New connections in the region

Due to the region's geography; solar, battery storage and offshore wind generation dominate this region for transmission connection applications. East Anglia is predominantly a net importer. However, growing renewable electricity generation connecting to this region means East Anglia is becoming a net exporter of power. Figure 2 below illustrates our expectations, as of July 2024, of around 60GW of generation to connect in the region over the period of 2024 – 2033. There is a strong likelihood not all this will connect to the network due to various reasons and so we continue to assess the likelihood that each contracted connection will proceed. However, we have a high confidence in offshore wind generation projects connecting into the areas.

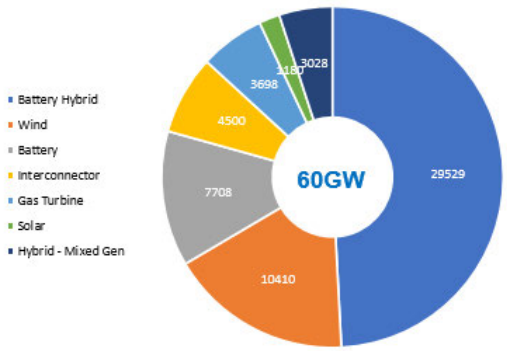


Figure 2: Expecting generation into the East Anglia region (2024 – 2033)

2.3 T3 Interactions

Although this MSIP is being submitted under the RIIO-T2 price control, it interacts with and forms part of the regional strategy outlined in NGET's RIIO-T3 Business Plan. The Walpole and Yaxley grid stability Pathfinders align with the ambitions set out in our business plan for the East Anglia

[5] East of England boundaries | National Energy System Operator

region, supporting the transition to a clean and futureproofed energy network. These Pathfinders play a critical role in addressing system stability needs, as the region connects new low-carbon electricity generation such as offshore wind, battery storage, and hybrid projects, which are components of the 12.6 GW of expected new generation in the region over the T3 period.

2.3.1 Alignment with Ofgem's RIIO-T3 consumer outcomes

Below we outline how the investments at Walpole and Yaxley deliver in accordance with Ofgem's RIIO T3 consumer outcomes,[6] which we believe set important markers to ensure our decisions provide value for existing and future customers.

Table 2: Investment alignment with Ofgem's consumer outcomes

Infrastructure fit for a low-cost transition to net zero	The investments at Walpole and Yaxley directly support the UK's transition to a low-carbon energy system by replacing stability services previously provided by fossil fuel generation with Synchronous Condenser technology.
High quality of service	By maintaining stability and reliability in an increasingly renewable-dominated grid, these investments contribute to a high quality of service for consumers. The projects mitigate the risks of interruptions or system failures caused by insufficient inertia and support during faults, contributing to consistent and reliable electricity supply.
System efficiency and long-term value for money.	NESO estimates that without the Pathfinder solutions across all regions, managing stability in England and Wales would cost an additional £14.9 billion between 2025 and 2035. This figure reflects the cost of balancing actions such as keeping fossil fuel plants online for their stabilising properties, which would otherwise be avoided through the installation of synchronous condensers. By reducing the reliance on costly constraint actions, the Walpole and Yaxley projects directly benefit consumers, leading to lower energy bills while supporting grid resilience.

[6] Ofgem kickstarts conversation on future energy price controls funding to pave the way for net zero | Ofgem

3. Establishing Need

3.1 Overview

Table 3: Summary of Investment Driver

Summary of Primary Driver		Date
NESO-driven Pathfinder Connection	**Grid stability – to provide new connections for contracted customer (Conrad Energy).** • Conrad Energy were awarded contracts to deliver their grid stability solutions at Walpole and Yaxley substations connecting Synchronous Condensers to the transmission system. • NGET has an obligation to connect Conrad Energy, as connection customers.	[redacted]

The Pathfinder connection projects at Walpole and Yaxley are driven by the outcome of NESO's Pathfinder programme, which seeks to address key system needs in the East of England region. This includes maintaining grid stability through the provision of short circuit level and inertia, supporting the integration of renewable energy in the East of England and facilitating the transition to net zero.

3.2. Grid Stability

Grid stability refers to the ability of an electricity network to maintain a steady and reliable flow of power despite fluctuations in demand, generation, or unexpected disruptions. It ensures the continuous operation of the grid within specified parameters, such as frequency, voltage, and power quality. Grid stability is achieved through several key components including, but not limited to, short circuit level (SCL) and Inertia. If the system becomes unstable it could lead to outages, impacting both consumers and the system's resilience.

Short Circuit Level (SCL)

SCL measures the ability of the system to handle faults (e.g., caused by weather, equipment failure, or lightning) by ensuring sufficient fault current for protective devices like circuit breakers to operate effectively. It is typically measured in mega-volt amperes (MVA). Historically, traditional generation provided significant SCL. However, the transition to renewable energy has reduced SCL levels, creating challenges in maintaining voltage stability and fault recovery.

A high SCL supports voltage stability, preventing large fluctuations during disturbances and helping the grid recover faster. If we operate a system with low SCL, it may take longer to recover after a disturbance.

NESO set out in their 2023 Operability Strategy Report[7]:

"*In order to manage low short circuit levels by 2035, we will need access to assets that have the capabilities to provide alternative solutions to our current approaches (which is often to curtail generation in areas where short circuit levels are low), and hence, our SCL requirement is currently an economic requirement, rather than compliance.*"

Inertia

Electricity for the grid is produced by generators moving large spinning parts. These parts rotate at the right frequency to balance supply and demand. The kinetic energy stored in these spinning parts is referred to as inertia. If there is a sudden change in system frequency, these parts will carry on spinning and slowdown that change, therefore helping to stabilise the grid after disturbances.

[7] NESO Operability Strategy Report December 2023

NESO set out in their 2022 Operability Strategy Report[8]:

"In the last decade the average annual system inertia has fallen by around 40%. Lower inertia means that system frequency is less resistant to change, so it will change more quickly when subject to an event, like a sudden loss of generation or demand"

NESO's identified regional grid stability requirements across all regions are highlighted in Table 4 below.

Table 4: Regional grid stability requirements determined by NESO

Region	Short Circuit Level (SCL) and Inertia Need
North-East England	500 MVA
East of England	2000 MVA
South coast	2000 MVA
South-West England	500 MVA
South Wales	2500 MVA
Total Inertia across all these regions	**15 GW. s**

3.3 Net-Zero – Integration of Renewable Generation

The East of England is a key region for renewable generation growth, with substantial wind and solar developments connecting to the grid. While these sources contribute to decarbonisation, they provide less SCL and no inertia, weakening the grid's stability. This necessitates the deployment of technologies like Synchronous Condensers to reinforce the grid locally and maintain reliable operation as renewable penetration increases.

The UK's status as one of the fastest decarbonising electricity systems in the world has implications for system stability management. Ensuring that net zero ambitions are met requires targeted solutions to address the stability challenges introduced by renewable integration.

3.4 Synchronous Condenser Technology

Synchronous Condenser is the technology to be connected by Conrad Energy as grid stability solutions for the East of England region. A Synchronous Condenser, also known as a Synchronous Capacitor or Compensator, is a specialised device designed to enhance grid stability and support voltage regulation. While it does not produce power, it plays a critical role in maintaining the reliability of the power network, particularly during system faults.

Traditional power stations, such as coal, gas, and nuclear plants, use rotating generators to provide synchronous generation, which inherently contributes to system stability. In contrast, renewable energy sources like wind and solar are non-synchronous, leading to reduced system inertia (the mass that helps control frequency) and lower short circuit levels (the current available during faults).

Synchronous Condensers replicate the stability benefits of traditional generators by delivering inertia and improving SCL, but without emitting CO2 or incurring the high operational costs associated with fossil fuel generation.

NESO established Stability Pathfinders to support the development and delivery of new technologies that provide these important system characteristics.

[8] NESO Operability Strategy Report 2022

3.5 Licence Obligations – Customer Connection & SQSS Requirements

As a licensed transmission owner, NGET has clear obligations to:

- provide the necessary transmission infrastructure works required to enable Conrad Energy to connect Synchronous Condensers at Walpole and Yaxley in line with their connection agreements and contractual obligations. Conrad Energy entered into connection agreements with NGET for both substations respectively in May 2023.
- Comply with System Security and Quality of Supply Standards[9] (SQSS), which require us to maintain system stability and security. This includes managing factors such as voltage control, frequency regulation, and fault level management. Whilst the SQSS does not specifically require the connection of Synchronous Condensers, it necessitates the implementation of appropriate measures to uphold system stability, which can include the integration of such equipment. We consider that facilitating the connections of the Synchronous Condensers at Walpole and Yaxley are a practical approach to meeting these requirements, as they provide the necessary inertia and fault level support.

3.6 Existing and planned future network

The East Anglian electricity transmission network is uniquely positioned as both a net importer and a potential net exporter of power, influenced by developments beyond the region. Power flows in the network are heavily impacted by offshore wind generation in the North and interconnector activity along the South Coast. As East Anglia evolves into an exporting region, the transmission network will predominantly facilitate north-to-south power flows, delivering renewable energy from offshore wind and nuclear power stations to London and Southeast England.

The East Anglia region is of strategic importance for the transmission of renewable energy from the North to Southern England and Europe. Significant developments are underway, including consented offshore wind projects, new interconnectors, and large-scale battery storage systems for wind and solar energy. With approximately 10% of the national power demand located within eastern England, the region's power transfer requirements are set to grow significantly in the coming years.

[9] GB Security and Quality of Supply Standard

4. Optioneering

4.1 Overview

This section summarises the options we considered to address the needs case established in the previous section in a way that best serves the interest of current and future consumers.

In line with our standard optioneering process, we considered several options for implementing the Pathfinder solutions at Walpole and Yaxley substations. However, NESO's advanced planning, supported by NGET's feasibility studies during the tender process, determined the suitability of Walpole and Yaxley substations and reserved the necessary connection bays at each substation. As a result, optioneering was limited to site-specific configuration of infrastructure to accommodate the Pathfinder solutions.

As a responsible Transmission Owner, we also reviewed whether alternative sites or constructing new assets would offer better outcomes for consumers. This was ruled out, as the existing infrastructure at Walpole and Yaxley, with appropriate modifications, remains the most efficient and practical solution to deliver within the required timeframes.

Table 5: Overview of options considered

Option	Description	Rationale
Do Nothing **Rejected**	No action is taken to implement stability solutions at Walpole and Yaxley	**System needs left unaddressed** NESO identified grid stability needs. Without action, these needs would remain unaddressed, leading to increased constraint costs, reliance on expensive balancing actions, and operational risks to the grid. Doing nothing would undermine grid reliability and the UK's net zero goals.
Build New or Use Alternative Substations **Rejected**	Construct entirely new substations or consider an alternative site to connect the Pathfinder solutions.	**Disproportionate solution relative to project driver** Deemed unnecessary due to the technical feasibility and sufficient capacity of Walpole and Yaxley substations for accommodating the stability solutions. Constructing a new substation or using alternative sites would involve significant costs, planning complexities, and extended timelines, making it incompatible with the Pathfinder programme's 2025 operational goal and process.
Use Existing Substations **Selected**	Extend and utilise the existing infrastructure at Walpole and Yaxley substations to connect the Pathfinder solutions.	**Sites confirmed as suitable during the Pathfinder process** Leverages existing spatial and technical capacity, as confirmed during the planning and tendering stages of the Pathfinder programme, delivering the identified consumer benefits within the necessary timeframes.

4.2 Stability Pathfinder Phase 3 Connections Approach

The Stability Phase 3 Pathfinder introduced a new connections process that enabled the reservation of connection bays at selected substations for the implementation of Pathfinder solutions (See Appendix A). This was a key change from previous Pathfinders, as it involved advanced planning to help streamline the connections process to expedite delivery of Pathfinder solutions.

Capacity Reservations at Walpole and Yaxley

After NESO identified the suitable substations to accommodate connections for the Pathfinder solutions, NGET were instructed to reserve capacity at these locations for the tender duration. Once successful Pathfinder participants were selected, they could then apply for connections with the reserved capacity available, avoiding the previous bottlenecks caused by large volumes of competing connection requests.

Both Walpole and Yaxley were reserved by NESO. The reservations were based on the SCL effectiveness of both substations relative to reference sites, as well the credible connections opportunities displayed by the substations (See Appendix B).

NGET Pathfinder Connection Feasibility Report

Following reservation of the sites by NESO, NGET conducted desktop feasibility studies on the reserved connection points. The feasibility report served as a validation tool for the reserved sites. The report sought to ensure that reserved sites, including Walpole and Yaxley (See Appendix C), were technically viable, cost-effective, aligned with Stability Phase 3 objectives and that constraints were considered. The findings from the report were shared with tender participants prior to the Pathfinder tender submission deadline to help them make informed bids and plan for connecting their solution(s) to the network through one of the reserved connection points in the report.

4.3 Detailed Analysis

With the substations confirmed, this section outlines the detailed analysis and site-specific configurations we applied for delivering the Pathfinder connections at Walpole and Yaxley. Both sites presented specific design considerations, which were carefully evaluated to ensure the best outcomes for consumers. This included addressing spatial constraints at Walpole and incorporating futureproofing at Yaxley through an expanded GIS design. Further details are provided in the subsequent sections below.

The process of assessing the location and connection for the Condensers at Walpole and Yaxley did not require a detailed cost benefit analysis (CBA). We deemed that carrying out a CBA was not proportionate to making these particular investment decision. Our assessment of the options has shown that the preferred option, as described in Section 5 below, offers the most efficient solution for consumers to meet the project drivers.

4.3.1 Walpole

Existing Site Arrangements

Walpole 400kV is an outdoor, double busbar, Air Insulated Switchgear (AIS) substation comprising 19 bays, including 2 Bus Section bays (Main and Reserve Bus Section 1) and 17 Circuit bays split across the busbar systems as follows:

- MBB1/RBB1 (11 circuits): Spalding North, SGT1, Burwell Main 2, SGT3, Necton-Norwich Main 2, Bus Coupler 1, Necton-Norwich Main 1, SGT5, Onshore Lincs, Race Bank 1, Race Bank 2.
- MBB2/RBB2 (6 circuits): Burwell Main 1, SGT2, Bicker Fen, SGT4, Bus Coupler 2, Sutton Bridge.

Of the 19 circuits, 7 are connected via overhead lines, which include:

- Necton-Norwich Main 1 & 2 (Route 4VV)
- Burwell Main 1 & 2 (Route 4ZM)
- Spalding North & Bicker Fen (Route 4ZM)
- Sutton Bridge (Route SB)

Within Walpole, NGET are developing a site strategy to accommodate the multiple customers that are expected to the site. This will include a new section to the 400kV substation to allow for additional generation and power flow. Full consideration of the site architecture was required to ensure that the

proposed site could be maximised not only for Conrad energy, but also for other customers and ensuring consumer value.

Change to initial reservation bay

As outlined in the previous sections, NESO had reserved space for a connection bay at Walpole for connection of the Pathfinder solutions. This bay was intended for Conrad Energy to use following successful awarding of their Pathfinder tender contract. Walpole is a congested site, so the reservation was made on the potential to implement a bay in the available space within the eastern section of the substation, opposite SGT5 (marked up in Figure 3 below). This arrangement would have required the existing substation fence to be moved or constructing a new lattice tower for clearances over the existing fence, along with diverting an existing culvert.

Subsequently, the introduction of a new NESO-driven scope of work, unrelated to the Pathfinders, required the accommodation of two Mechanically Switched Capacitors (MSCs) and therefore necessitated a reconsideration of the spatial arrangements.

It was determined that one MSC would be best located in the space originally reserved for Conrad Energy's connection, as this placement offered the most suitable fit given spatial constraints. The MSC required more space than potentially could have been made available at the far eastern section of the substation, which was the only other alternative. As a result, Conrad Energy's connection bay was relocated to the far eastern section of the substation instead, therefore allowing the MSC to occupy the originally planned location for their Condenser.

4.3.2 Yaxley

Planned site arrangement

Yaxley substation, currently under development and scheduled for completion in 2025, is designed to connect Progress Power's 299MW Open Cycle Gas Turbine (OCGT) generation to the transmission network. The substation is located on land owned by Progress Power, with NGET leasing the area designated for the substation.

The Yaxley 400kV substation will be a Gas Insulated Switchgear (GIS) facility, featuring six bays housed within an indoor GIS hall. These bays will accommodate the following connections:

- Bramford-Norwich Main 1 (via a 400kV underground cable to an overhead line connection).

- Bramford-Norwich Main 2 (via an overhead line connection).
- Progress Power OCGT generation
- Bus Coupler
- Two additional customer bays (1 for the Pathfinder and 1 for future connections)

Initial Design: 4- bay GIS Substation

The original design for the Yaxley substation without the Pathfinders featured a four-bay GIS configuration (see Figure 4), accommodating the required bays for Progress Power's connection. This design was compact and aligned with the needs at the time of planning.

Expansion to six bays to accommodate Pathfinders

Following the introduction of the NESO-driven stability Pathfinders in 2021, NGET decided to progress with the development of Yaxley substation with the inclusion of a six-bay design (see Figure 5), instead of four, which would accommodate the connection of two synchronous condensers for Conrad Energy via the inclusion of two additional bays. This adjustment required resizing the substation building, including the GIS hall and control systems, to ensure sufficient space for the new infrastructure and maintenance access. The integration of the additional bays in the substation's overall delivery program for Progress Power was considered to deliver the best value for consumers, as the approach allowed for efficient implementation during the substation's initial build phase, avoiding costly retrofitting later.

Assessments determined that the additional two bays could be incorporated within the existing Development Consent Order (DCO) footprint, minimising disruption to the planning framework. However, this expansion increased the overall size of the substation building, requiring consultation with the Planning Authority. Planning permission was granted in 2022.

NESO reassessment of stability needs at Yaxley

By September 2022, NESO assessed and concluded that only one Synchronous Condenser would now be required at Yaxley to meet short circuit level and inertia requirements in the region. This was because contracts awarded across the East of England addressed stability needs at multiple locations, reducing the need for a second condenser at Yaxley. In light of this, we assessed whether to continue with the construction of the second additional bay (i.e. whether to now proceed with the construction of six bays or five bays).

NGET assessment of the additional bay

We conducted an internal assessment to decide whether to proceed with building the second bay at Yaxley, given that any additional cost to consumers beyond the NESO instruction for one condenser would not be funded. Although this MSIP does not include funding for the second bay, we are providing our approach for informational purposes.

Our analysis highlighted that the decision to proceed hinges on the likelihood of future customer connections. If there is reasonable confidence in a future connection, constructing the second bay

upfront would be more cost-effective than retrofitting at a later stage, minimising both financial and operational impacts.

Potential for future connections at Yaxley

We then assessed the potential for future connections that could utilise the additional bay at Yaxley. The following indications had been received from customers expressing interest in connecting at the site at the time (November 2022):

Based on the assessments taken and connection interest from potential customers, we concluded that the risk of proceeding with the construction of the second bay at Yaxley is low. Continuing with the build will ensure the site is ready to accommodate future connections in a cost-effective way. Therefore, we considered that there was value for future consumers in proceeding with the build of the additional bay to support future connections and maximise the site's utility.

This additional bay is not part of the funding request for this MSIP paper as only one of two additional bays will be connecting to with Conrad Energy's Condenser.

5. Preferred Solution

In line with NESO's Pathfinder request and following our site-specific analysis, we are facilitating the connection of two new Synchronous Condensers at Walpole and one at Yaxley. These installations will enhance system stability as the grid transitions to net zero, reducing balancing costs for the benefit for consumers. The specific scope of works to achieve the connection of the Condensers, including the division of work between NGET and Conrad Energy for each site, is as follows:

5.1 Walpole

Works at Walpole

Following the change to the position of the Conrad Energy's Pathfinder connection bay, NGET's scope of works will include extension of the existing 400kV AIS substation to the east - including the required modifications to the perimeter fence and outdoor lighting. The design, supply, construction, installation, testing and commissioning of the Synchronous Condenser Bay equipment and its associated Portable Relay Room (PRR) will be carried out by Conrad Energy and is outside the scope of this funding request.

Table 6: Summary of the scope of Pathfinder connection works at Walpole

Scope of Works for the Walpole Pathfinder connection	
Conrad Energy (Note: Conrad Energy's scope of works is not part of this MSIP funding request and have been included for informational purposes only)	**NGET**
User Bay Installation • A new user bay will be installed at the Walpole 400kV substation, providing a connection point for Conrad Energy's equipment to integrate their synchronous condenser into the National Grid network **Construction of two new Synchronous Condensers** • Two new Condensers will be constructed on land adjacent to the southern boundary of the existing Walpole 400kV substation • Includes all ancillary equipment necessary for its operation, such as cooling systems, auxiliary power supplies, and control/protection systems. **Cable installation** • A short 400kV underground cable will connect the synchronous condenser located on the adjacent site to the substation. This cable will link directly to the user bay, ensuring integration into the substation infrastructure.	To facilitate the connection of the new synchronous condenser and ensure compliance with transmission system standards, the following reinforcement and construction works will be undertaken by NGET at the Walpole substation: **Substation Extension** • The eastern section of existing substation platform will be extended to accommodate the additional user bay. This extension includes associated civil works. • The Main 1 and Reserve 1 busbars at the substation will be extended to enable the connection of the new user bay. These extensions will provide the necessary electrical infrastructure for Conrad Energy's equipment. • The substation fence-line will be extended to secure the expanded area. This includes removal of existing fence, installation of a new section of fence, and new substation surfacing • Demolition of existing site office to accommodate new bay and diversion of services • New permanent services as replacement to existing site office. **Busbar protection** • An extension to the busbar protection system will be installed to accommodate the extended busbars and the new user bay. This system is critical for isolating faults and preventing failures. **SCS extension** • Substation Control System (SCS) work to accommodate new bay. **Cable preparation** Trenching and ducting works to enable laying and protecting of the cables. **Other Civils** Connection of new surface water drainage into the existing/ standalone surface water network.

5.1.1 Siting of the Walpole Condensers

Conrad Energy obtained the necessary land and planning consents for a site at Rose Hall Farm, Walpole Bank, which was selected due to its proximity to the substation, suitable size, and existing access infrastructure. The two Condensers will be housed side by side in a 12m-high warehouse-style building on the site, with external components like coolers, transformers, and other ancillary equipment placed nearby. The site is located to the south of Walpole substation.

Figure 8: Siting location for the Condensers adjacent to Walpole Substation

5.2 Yaxley

Works at Yaxley

The Pathfinder connection works at Yaxley substation are integrated with the construction of the substation for Progress Power. The additional bay required for the Pathfinder project, along with the bay reserved for future connections, has been delivered and integrated into the overall construction of the substation for Progress Power. None of the these additional are the subject of a funding request in this MSIP as the cost of the Pathfinder bay is apportioned to Conrad Energy, and the cost of the bay for future connections will be apportioned once a connection is secured.

The inclusion of the Pathfinder bay in the design and construction phase of Yaxley substation enabled efficiencies to be realised. By incorporating the additional bays during the initial construction phase, the need for future retrofitting is avoided, ensuring the site is future-ready while effectively managing shared resources and timelines.

Table 7 below distinguishes the scope of works at Yaxley for NGET and that of Conrad Energy. Works relevant to Conrad Energy do not form part of the funding request for this MSIP, and are only included for information purposes.

Table 7: Summary of the scope of Pathfinder connection works at Yaxley

Scope of Works for the Yaxley Pathfinder connection	
Conrad Energy (Note: Conrad Energy's scope of works is not part of this MSIP funding request and have been included for informational purposes only)	**NGET**
Construction a Synchronous Condenser • Construct and install a single synchronous condenser unit on land adjacent to the Yaxley substation. • Includes all ancillary equipment necessary for its operation, such as cooling systems, auxiliary power supplies, and control/protection systems. **Cable installation** • Install high-voltage cables to connect the Synchronous Condenser to the substation. **Civils, Mechanicals & Electricals** • Civil and M&E works including ground concreting on site adjacent to NGET substation.	**GIS Bay Installation** • Procurement, installation, and commissioning of 400kV GIS Bay (1 Bay). This has already been completed as part of the wider construction of the substation for Progress Power for efficiency. Costs of this are apportioned to Conrad Energy and are therefore not part of the scope of this funding request. **Gas Insulated Busbar (GIB)** • Procure, install, and commission the GIB to connect Conrad Energy's equipment to the substation – see Figure 10. **Civils and Electrical:** • Associated civil and electrical works - supporting structures, and control systems.

5.2.1 Siting of the Yaxley Condensers

Figure 11: Siting location for the Condensers adjacent to Yaxley substation

5.3 Summary of Pathfinder solutions to be connected by NGET

Table 8: Stability Pathfinders project summary

Summary									
Site	Rating	Customer	Condensers	Condenser Location	SCL* Bicker Fen/Norwich (MVA)	Inertia (Mw.S)	Connection Bay	Scope of Works	Delivery/ACL
Walpole	400kV	Conrad Energy	2	Adjacent site to the substation	589/1355	1225	Far eastern end of the substation	Infrastructure works to extend the sub	[redacted]
Yaxley	400kV	Conrad Energy	1	Adjacent site to the substation	893/236	617	Within indoor GIS hall	Implementation into developing substation construction	[redacted]

6. Detailed cost for preferred solution

6.1 Introduction

This section provides a breakdown of the overall costs for the Walpole and Yaxley Pathfinder connection projects including an expenditure profile for all Regulatory Years of delivery. The breakdown represents our latest view of costs for the proposed investment and all costs are presented in 2018/19 price base, unless otherwise stated.

The contracting arrangement associated with the Walpole investment (i.e. the use of an Option E contract) means that NGET will not achieve cost certainty on the project until [redacted] as informed to Ofgem, therefore initial costs included within this MSIP submission for Walpole are internal estimates only at this stage, based on the defined scope as detailed within the direct allocation documentation.

Upon achieving greater cost certainty in line with the dates advised to Ofgem in January 2025, NGET will subsequently provide an updated cost submission for this MSIP Re-opener. This submission will detail the market tested pricing received and request full funding allowances for the scheme.

Appendix E, Cost Model, submitted alongside this document provides a breakdown of the costs for Walpole and Yaxley in more detail and should be reviewed alongside this chapter.

This Chapter is broken down into the following sections:

- Total Allowance Request
- Cost Summary
- Cost Firmness

6.2 Total Allowance Request

The MSIP reopener mechanism is subject to the Opex escalator and therefore indirect costs will be funded under this route.

Walpole

Total project costs for Walpole are [redacted] NGET requests [redacted] allowance is provided through the MSIP reopener mechanism to recover the direct portion of costs and deliver works described above. The MSIP reopener mechanism is subject to the Opex escalator and therefore indirect costs will be funded under this route.

Table 9: Walpole Allowance Request

2018/19 price base					
£	2023/24	2024/25	2025/26	2026/27	Total
[redacted]					

Yaxley

Total project costs for Yaxley are [redacted]. NGET requests [redacted] allowance is provided through the MSIP reopener mechanism to recover the direct portion of costs and deliver works described

above. The MSIP reopener mechanism is subject to the Opex escalator and therefore indirect costs will be funded under this route.

Table 10: Yaxley Allowance Request

2018/19 price base						
£	2022/23	2023/24	2024/25	2025/26	2026/27	Total
[redacted]						

6.3 Cost Summary

Table 11 and 12 below shows a summary of total project costs for each project.

Walpole

The total cost to develop and deliver the project at Walpole is [redacted] including indirect costs and costs incurred to date.

Table 11: Walpole Cost Estimate

Element	Total (2018/19 price base, £)	Classification
Contractor Costs		
Main Works Contractor	[redacted]	Direct
Third Party Costs		Direct/CAI
National Grid Costs		
ET Ops		Direct
Project Management		CAI
Project Services		CAI
Support Functions		CAI
Consents		Direct
NGET Portfolio Costs		CAI
Other		
Contract Inflation		Direct
Risk		Direct
Total		

Yaxley

The total cost to develop and deliver the project at Walpole is [redacted] including indirect costs and costs incurred to date.

Table 12: Yaxley Cost Summary

Element	Total (2018/19 price base, £)	Classification
Contractor Costs		
Main Works Contractor	[redacted]	Direct
Third Party Costs		Direct/CAI
National Grid Costs		
ET Ops		Direct
Project Management		CAI
Project Services		CAI
Support Functions		CAI
Lands		Direct
NGET Portfolio Costs		CAI
Other		
Estimated Inflation		Direct
Risk		Direct
Total		

6.4 Cost Firmness

Table 14 and 15 below show the assessment of cost firmness using the classification outlined in the Ofgem LOTI reopener guidance document published on 29th March 2021.

Walpole

The 5% cost firmness for Walpole is reflective of its contractual structure under an Option E contract, which is a cost-reimbursable agreement. Under this contract type, the contractor is reimbursed for actual costs incurred, with minimal cost certainty at the outset. The 5% cost firmness indicates an initial estimate with significant scope for adjustment as the project progresses, aligning with the flexible nature of Option E.

Table 13: Cost Firmness for Walpole

Cost Firmness	Total (£) 2018/19 price base	Notes
1 - Fixed	[redacted]	Actuals
2 - Agreed remeasurable		
3 - Agreed remeasurable future information		Contractor
4 - Estimated		Risk, NG costs, Third Party and Estimated Inflation (less actuals)
5 - Early Estimate		
Total		

Yaxley

For Yaxley, 86% of the total costs (firmness 1 and 2) are either incurred or have been contracted, giving high confidence in our cost submission.

Table 14: Cost Firmness for Yaxley

Cost Firmness	Total (£) 2018/19 price base	Notes
1 - Fixed	[redacted]	Prior costs and 2024/25 actuals
2 - Agreed remeasurable		Contractor (less actuals)
3 - Agreed remeasurable future information		Third Party
4 - Estimated		Risk, NG costs and Contract Inflation (less actuals)
5 - Early Estimate		
Total		

Estimated costs relate to NGET resource costs, calculated based on forecast days and standard rates, as well as risk for the remainder of the project.

7. Deliverability and risk

7.1 Deliverability

This section sets out a summary of the key activities pertaining to the delivery of the Pathfinder projects, including the current high-level programme plan, procurement strategy and anticipated risks.

7.1.1 Delivery Programme

The project programmes are outline in Table 16 and 17 below.

Walpole

Table 15: Outline of the key project milestones at Walpole

Milestone	Date
Contract Award	[redacted]
First Site Access	
Outage	
ACL	
Completion	

The project was awarded in [redacted] as Option E, with energisation scheduled for [redacted] NGET are currently on track to achieve site mobilisation by [redacted] Detailed design work is in progress, along with the development of all safety documents and pre-site mobilisation activities, including construction design and management (CDM) layouts.

We are maintaining regular engagement with the contractor and Conrad Energy (the customer). Conrad Energy has ordered long lead equipment and are designing for their connection bay, with plans to award their construction contract before [redacted] The synchronous condenser work, as informed by Conrad Energy, is at an advanced stage.

Outages for [redacted] will be initiated once Conrad agrees to the proposal for a new ACL date, which we are requesting to be brought back from the current [redacted] for earlier delivery of the project. Various interface meetings with all relevant stakeholders have been conducted, and a robust programme is being developed to achieve the outage and energisation milestones. The outage will be requested with NESO once all interfaces with stakeholders are agreed upon.

Yaxley

Table 16: Outline of the key project milestones at Yaxley

Milestone	Date
Contract Award	[redacted]
First Site Access	
Outage	
ACL	
Completion	

[redacted] NGET are currently on track to meet the [redacted] connection date. The order has been placed for the remaining HV equipment (including GIB) due for delivery in [redacted] The GIS Bay and building

works have been installed and are due to be commissioned [redacted]. Key NGET commissioning resource has been allocated to the scheme in line with the programme. There is ongoing design and site engagement with the Customers works.

7.1.2 Procurement and Contracting Strategy

Summary of the procurement strategy taken, including contracting arrangement and how value is being derived from the contract.

Walpole

Walpole was progressed using an Early Contractor Involvement (ECI) strategy to ensure an efficient and coordinated approach to the overall site strategy. Under this strategy, the contractor responsible for developing the design during the tender phase continues as the delivery contractor. This approach ensures continuity between design and execution, optimising integration and reducing inefficiencies during implementation.

Given the tight supply chain market and the urgency to meet the ACL date, the decision was made to proceed under an [redacted]. While Option E is not typically preferred due to the lower cost certainty, it was deemed the only viable option to meet key project timelines. Ensuring timely delivery was essential, as delays would impact the wider system and prevent Conrad Energy from meeting its contractual obligations with NESO.

To mitigate cost escalation risks, the contractor will have an onsite Quantity Surveyor (QS) to monitor and control costs in real time. Additionally, NGET will strengthen its onsite QS presence to provide enhanced oversight, ensuring tighter cost management and greater transparency throughout project delivery.

Yaxley

The Conrad Energy Yaxley project is being delivered as an extension of the ongoing [redacted] to design, install and commission the new Yaxley 400kV substation. Utilising the ongoing NEC contract to deliver the works meant that the changes to the substation buildings and GIS were done during the design stage, minimising rework and additional cost.

7.2 Risk and Risk Management

A risk management process has been used for managing reasonably foreseeable risks. The process employed is in line with ISO 31000:2009, Risk Management – Principles and Guidelines.

Table 18 and 19 below lists the key risks identified for the Walpole and Yaxley Pathfinder projects, although the full Risk Register is included within tab 4.1 of the Cost Model appended to this submission (Appendix 5).

Table 17: Delivery risks for the Walpole Pathfinder project

Risks	Mitigation
Project Delays Delays to project completion due to contractor resource constraints and governance issues, stemming from the high volume of projects being managed. This has affected construction timelines and cable connections.	NGET will chair weekly progress meetings to monitor timelines and ensure accountability. The early warning process, as governed by the contract, will be actively utilised to identify and address potential delays promptly.

Risks	Mitigation
Outages Securing the required outage dates in Norfolk is challenging due to the high volume of work and system constraints, which may impact project milestones.	NGET will proactively engage with NESO to secure outage dates early and ensure alignment with project requirements.
Site (Methodology of Foundation/Piling Works) The use of piling methods (e.g., vibration) could inadvertently trip existing relays, leading to an unplanned outage of the bay.	Contractors will adopt alternative foundation methods that minimise vibration to avoid triggering relay trips within the 400kV substation.
Capacity of existing Drainage The existing drainage system may lack the capacity to handle the new extension, potentially leading to additional project costs.	Contractors will assess the drainage system and propose a standalone drainage solution if the existing system cannot meet the required capacity.
Cost Escalation The tight supply chain market and the urgency to meet the revised ACL date necessitated the adoption of an Option E contract, which carries inherent risks of cost escalation.	To address these risks, the contractor will have an onsite Quantity Surveyor (QS) to monitor costs in real-time, and NGET will increase its own onsite QS presence to provide enhanced oversight and tighter cost control.

Table 18: Delivery risks for the Yaxley Pathfinder project

Risks	Mitigation
Supplier Design The Gas Insulated Busbar (GIB) manufacturer has previously made changes to the design specification of GIB's they produced which has resulted in a long procurement lead time. This has been a primary source of delay to project programme. Further manufacturer programme issues could result in further delays.	We have introduced additional project management support to monitor the contractor to anticipate risks and plan accordingly.
Interface with Other Schemes Other projects impacting availability of key resource or system access.	System access coordination managed through NGET TP153 process and monthly update at cross-function meetings with NGET Asset Operations and NG Strategic Infrastructure.
Customer Alignment [redacted]	Monthly management level coordination meetings are in place with the customer to review progress.
HV Test Kit availability HV Test Kit availability constraints delaying commissioning works.	Close coordination with General Electrics (GE). GE are aware of programme status as their engineers supervise the GIB installation.
Site Acceptance Testing failure Risk that equipment or systems fail site acceptance testing.	SAT tests to be delivered in line with Inspection and Test Plans and Quality Plans.

8. Conclusion

This document is NGET's MSIP re-opener submission to Ofgem for the Walpole and Yaxley Grid Stability Pathfinder projects. It is submitted with reference to Special Condition 3.14 of NGET's Transmission Licence.

Table 19 below summarises the main investment driver, the selected option, estimated costs and expected outputs.

Table 19: Project Investment Summary

<table>
<tr><td>Main drivers</td><td colspan="3">NESO driver to address identified regional grid stability needs in the East of England as identified by NESO in the Stability Pathfinder programme. The phasing out of traditional generation has contributed significantly to the gap in grid stability capabilities for the region.</td></tr>
<tr><td>Selected Option</td><td colspan="3">Infrastructure works and configurations to enable the connection of Synchronous Condensers in reserved capacities at Walpole and Yaxley substations.</td></tr>
<tr><td rowspan="2">Estimated Cost

(18/19 Price Base)</td><td colspan="3">Our total cost for the investment and funding allowance being sought for Walpole and Yaxley respectively is:
The current total cost of the projects is [redacted] and [redacted] respectively.
The total direct cost of the projects – the funding this MSIP seeks – is [redacted] and [redacted] respectively.</td></tr>
<tr><td>T2 (FY2022 – FY2026):
Walpole: [redacted]
Yaxley: [redacted]</td><td>T3 (FY 2027 – FY2031):
Walpole: [redacted]</td><td>T4+ (FY 2032+):</td></tr>
<tr><td>Outputs</td><td colspan="3">Integration of Synchronous Condensers to meet regional stability needs, providing inertia and short circuit level (SCL) support amidst growing renewable generation. The Pathfinder solutions across all regions, including the East of England, present the opportunity to save consumers billions in balancing actions that would alternatively be taken by NESO in the absence of the Pathfinders.</td></tr>
<tr><td>PCD Primary Outputs</td><td colspan="3">Extension of the substation and associated works at Walpole to connect Conrad Energy's NESO Pathfinder solutions by [redacted]
Installation of a substation bay and associated works at Yaxley to connect Conrad Energy's NESO Pathfinder solutions by [redacted]</td></tr>
</table>

Following a NESO-driven investment driver to enhance grid stability in the East of England, NGET will implement infrastructure works to connect Synchronous Condensers at both Walpole and Yaxley substations as grid stability solutions.

At Walpole, the solution is to extend the 400kV substation to accommodate a user bay to host the connection of the Synchronous Condensers. At Yaxley, the solution is to integrate an additional bay into the design and construction of the developing substation to accommodate the connection of the Condensers. Another bay which was also constructed for a Condenser, but no longer required, will be used to facilitate future customers.

The investment in infrastructure works to facilitate the projects enable the delivery of essential grid stability services and support the long-term energy transition, protecting the interests of both current and future consumers.

9. RIIO-T1 and RIIO-T2 allowances

There were no investments proposed for both projects during either RIIO-T1 or T2 business plans submissions and so no funding was received. The Projects do not have funding through any other price control mechanism.

10. Assurance and Point of Contact

Attached to this submission is the assurance statement letter, providing written confirmation in line with the assurance requirements set out in Ofgem's Re-opener Guidance and Application Requirements Document, dated 17th February 2023.

This confirmation is provided by the Head of Future Price Controls, Electricity Transmission. They provide the following statements below regarding how this MSIP application has been prepared and submitted in relation to each of the three assurance points requested by Ofgem:

a. It is accurate and robust, and that the proposed outcomes of the MSIP submission are financeable and represent best value for consumers.

b. There are quality assurance processes in place to ensure the licensee has provided high-quality information to enable Ofgem to make decisions which are in the interests of consumers.

c. The application has been subject to internal governance arrangements and received sign off at an appropriate level within the licensee.

NGET's designated point of contact for this MSIP application is Leo Michelmore, Strategic Upgrade Regulatory Manager (leo.michelmore@nationalgrid.com).

Appendices

Appendix A: New Connections Approach for Stability Pathfinder Phase 3

The Stability Phase 3 Pathfinder introduced a new connections process that enabled the reservation of connection bays at selected substations for the implementation of Pathfinder solutions. This was a key change from previous Pathfinders, as it involved advanced planning to help streamline the connections process to facilitate a timely delivery of the Pathfinder solutions.

The Need for change in approach

In the traditional connection process for Pathfinder projects, successful participants in NESO's competitive tenders would apply for a connection independently, following the standard process outlined in Section D, Part 2 of the System Operator – Transmission Owner Code (STC). This standard process requires NESO and TOs, including NGET, to treat each connection request in order of application.

A change in approach for Pathfinders was identified[10] by NESO and NGET as necessary to address inefficiencies in the connection process:

- independent connection applications created artificial Transmission Entry Capacity (TEC) queues, delaying offers, inflating costs, and disadvantaging some participants.
- The process also overwhelmed TOs and NESO, causing delays in tender timelines and impacting non-Pathfinder customers.

For Grid Stability Pathfinder Phase 3, an alternative trial connection process was proposed to address these issues. The trial process would enable NESO to reserve connection points at substations for successful Stability Phase 3 tender participants, avoiding the need for premature connection applications, and streamlining the tender process,

Regulatory Context and Approval

- To trial this revised approach for Stability Phase 3, NESO and NGET requested relief from Ofgem from compliance with the traditional connection process defined in STC Section D, Part 2.
- Ofgem granted[11] a temporary exemption under Standard Licence Condition (SLC) B12,. enabling NGET and NESO to reserve capacity and follow the revised process in 2022
- This direction applied exclusively to Stability Phase 3 Pathfinder and expired once successful participants would submit connection applications.

[10] Connections Approach for the NOA Pathfinder Stability Phase 3 Tender September 2021

[11] Direction to relieve National Grid Electricity Transmission Plc and National Grid Electricity System Operator Limited of the obligation to comply with Section D Part 2 of the SO-TO Code for Pathfinder connections | Ofgem

Appendix B: Basis for NESO reservations at Walpole and Yaxley Substations

Both Walpole and Yaxley were reserved by NESO for the Pathfinder process. NESO's reservations were based on the SCL effectiveness of both substations relative to reference sites, as well the credible connections opportunities displayed by the substations.

Reference sites and SCL effectiveness threshold

In the Stability Phase 3 Pathfinder, reference sites are critical locations identified by NESO within each region of need. These sites are chosen because they provide the highest SCL effectiveness for that region, making them the most suitable points/ benchmark to determine whether a substation or location within the region can contribute effectively to the region's needs.

SCL is highly locational in nature, with its effectiveness dropping sharply as the electrical distance from the reference site increases. A solution deployed further from the reference site contributes less to the overall SCL requirement. For the East of England, the reference sites were Bicker Fen 400kV and Norwich Main 400kV.

A hard threshold of ≥35% SCL effectiveness relative to reference site was set by NESO. Only substations meeting this threshold were included in the tender for that region. Effectiveness to a reference site refers to the ability of a substation to contribute to the required SCL or stability services at the reference site. It is expressed as a percentage and reflects how well the substation can support the system requirements at the reference site based on electrical distance, system topology, and other network characteristics. System studies inject SCL values at potential substations and simulate how much of that SCL reaches the reference site. For example, if a substation injects 1,000 MVA of SCL, and 350 MVA reaches the reference site, the substation's effectiveness to the reference site is 35%.

Both Walpole and Yaxley substations met this reservation threshold.

Credible connection opportunities

Substation sites across the regions of need were also reserved on the basis of demonstrating more credible connection opportunities than other sites within the specific area of need, given the current connection background.

Table 20: Basis for NESO reservations at Walpole and Yaxley substations

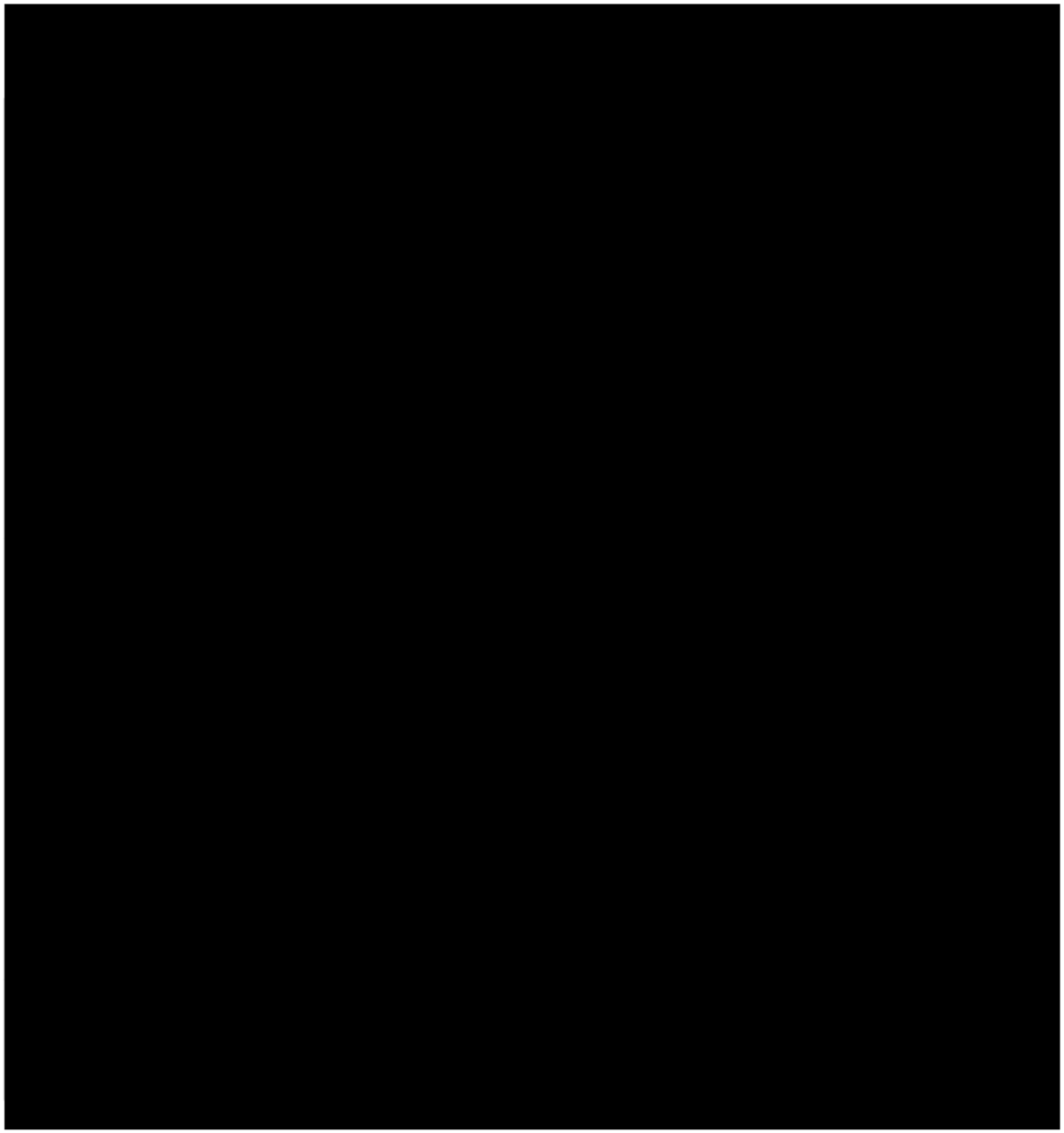
Requirement	Details	Walpole & Yaxley
Technical Effectiveness	Substations in the East of England must contribute to the region's 2,000 MVA SCL requirement and demonstrate ≥35% MVA effectiveness relative to reference sites (Bicker Fen 400kV and Norwich Main 400kV).	NESO system studies determined that Walpole and Yaxley met the ≥35% effectiveness threshold. Both substations are located in close proximity to the Bicker Fen and Norwich Main reference sites, and are therefore capable to delivering minimal electrical losses - ensuring high SCL effectiveness and a strong regional impact.
Connection Viability	Substations must have available bays or the potential to create them, with minimal planning or land constraints.	Walpole: identified as having option to create spare bay into vacant land. Yaxley: Identified as having opportunities for new connections with minimal interaction issues and planning risks.

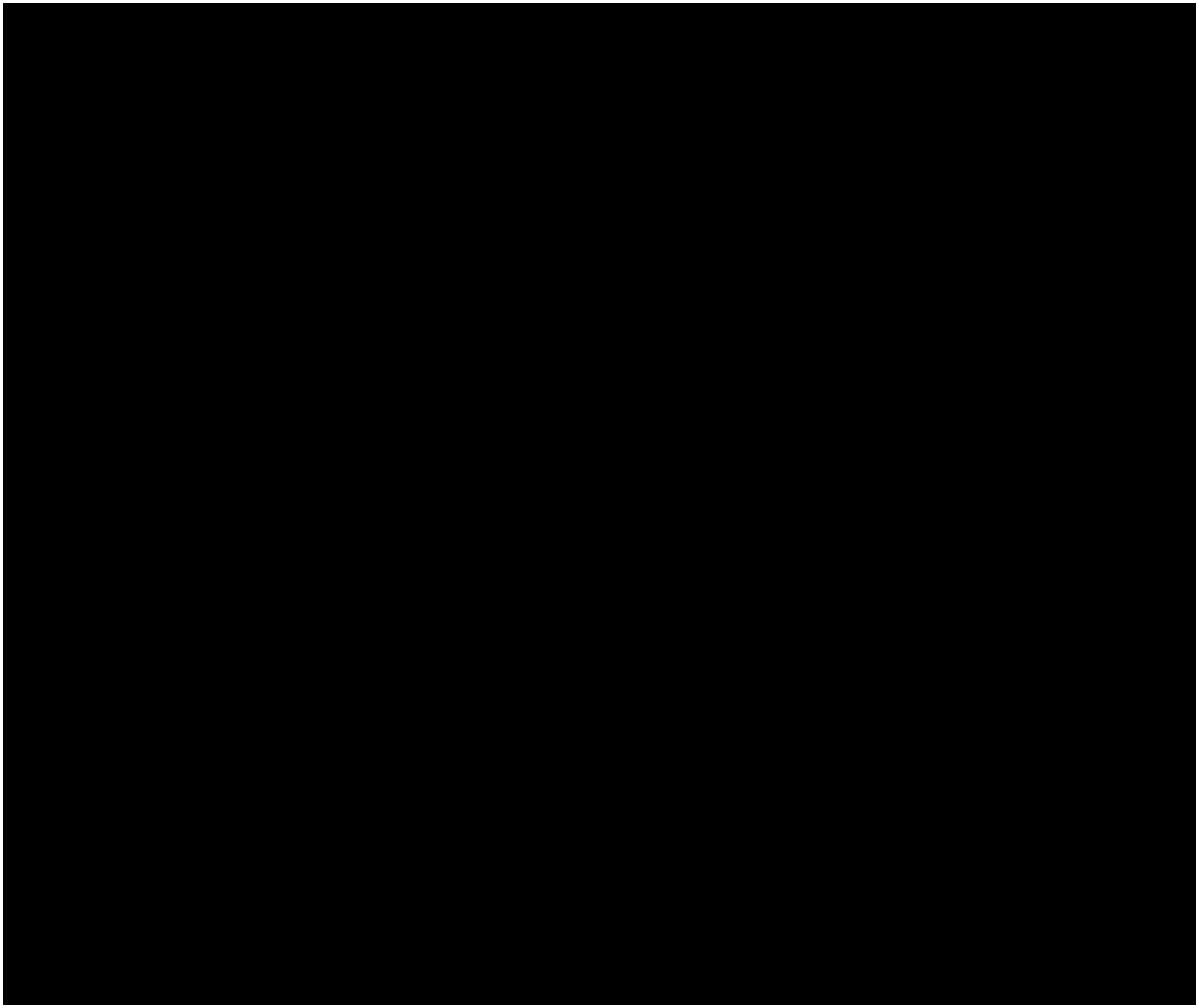
Appendix C: Summary of feasibility study outcomes for Walpole and Yaxley Substations

Table 21: Pathfinder Feasibility Study outcomes for Walpole and Yaxley substations (2022)

NGET Stability Phase 3 Feasibility Study		
Aspect	**Walpole Details**	**Yaxley Details**
Reservation of Bays	Space reserved adjacent to SGT5 for bay population, contingent on planning permissions and site constraints.	Two GIS bays reserved for Stability Phase 3, contingent on planning permissions and compliance with DCO conditions.
Substation Design and Status	Congested 400kV site with no existing spare bays. The last available bay is taken by a circuit diversion. Reservation depended on space adjustments near SGT5.	Indoor GIS substation with a double busbar configuration. Initially planned to connect a 299MW OCGT generator.
Technical and Planning Challenges	Substation expansion limited by surrounding constraints (road, flood defences, and arable land). Fence relocation and culvert diversion required.	Footprint and height constrained by DCO. Planning Authority approval required for additional bays. Decision anticipated in March 2022.
Alignment with Stability Scope	Stability bays aligned with ongoing site operations.	Pathfinder connection bays can be integrated into ongoing works to avoid additional outages.
Estimated Costs	Estimated infrastructure cost: £1m. Additional costs: £250k for buried service diversions and £150k for fence relocation.	Infrastructure costs estimated at £2.7m for two connection points. Connection asset costs estimated at £3.5m (based on CUSC boundaries).
Land and Access Considerations	Site constrained by flood defences, roads, shared access with the DNO, and multiple customer connections requiring coordination for cable routes.	Site leased by NGET from Progress Power. Northern access restricted by Leys Lane. Cable easements require agreements with Progress Power.
Outage and Resource Planning	Outage availability in 2024 and 2025 identified, but additional customer connections in 2023-2025 may impact coordination.	No additional outages anticipated as Stability works align with ongoing construction schedule.
Conclusions and Recommendations	Reservation of space adjacent to SGT5 remains feasible, with dependencies on planning permissions and site-specific adjustments.	Reservation of two GIS bays can proceed, contingent on planning permissions and integration into delivery programme. Final design approval required.

Appendix D: Enlarged drawings of solutions





Appendix E: Cost Models

Please see the accompanying Cost Models submitted alongside this MSIP.

'Appendix E.1 – Walpole Cost Model – MSIP Jan25'

'Appendix E.2 – Walpole Estimated Inflation – MSIP Jan25'

'Appendix E.3 – Yaxley Cost Model – MSIP Jan25'

'Appendix E.4 – Yaxley Estimated Inflation – MSIP Jan25'

Appendix F: Glossary

Acronym	Definition
MSIP:	Medium Size Investment Project
NESO:	National Electricity System Operator
NGET:	National Grid Electricity Transmission
SCL	Short Circuit Level
GSP:	Grid Supply Points
GIS:	Gas Insulated Switchgear
GIB:	Gas Insulated Busbar
ISS:	Integrated Security System
SCS:	Substation Control System
OCGT:	Open Cycle Gas Turbine

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